

Claims

- 1) A process for the production of a safety helmet which comprises an energy
dispersive polymer composite sandwich structure, comprising the steps of;
5 a) introducing into a mould a first layer comprising at least one piece of fabric, a
second layer comprising a pre-formed energy dispersive material, a third layer
comprising at least one piece of fabric and a curable polymer material in contact
with at least said first and third layers, and
b) curing the polymer material such that first and third fibre reinforced polymer
10 layers are formed encapsulating the second layer.
- 2) A process as claimed in claim 1 wherein the first layer and some curable
polymer material are introduced into the mould prior to introduction of the
second layer and the third layer and some curable polymer material are
15 introduced into the mould subsequent to the introduction of the second layer.
- 3) A process as claimed in claim 1 wherein the first layer of fabric is bonded to the
second layer prior to introduction into the mould.
- 20 4) A method as claimed in claim 3 wherein some curable polymer material is
introduced into the mould prior to introduction of the bonded first and second
layers.

- 5) A method as claimed in any of claims 3 or 4 wherein the third layer of fabric is bonded to the second layer prior to introduction to the mould.
- 6) A method as claimed in claim 5 wherein at least some curable polymer material is applied to the third layer after it is bonded to the second layer.
- 7) A method as claimed in claim 6 wherein the curable material applied to the third layer is applied after the third layer has been introduced into the mould.
8. A process according to any one of the preceding claims wherein each of the first and third layers comprise in the range of from 1 to 4 sheets of fabric.
9. A process according to any one of the preceding claims, wherein the first and third layers are produced from substantially the same fibre reinforced polymers.
10. A process according to any one of the preceding claims wherein the first layer, fibre reinforced polymer, is produced to a thickness in the range of 0.2mm to 6mm.
11. A process according to claim 10 wherein the thickness of the first layer is in the range of 0.3 mm to 1mm.

12. A process according to any one of the preceding claims, wherein the third layer, fibre reinforced polymer, is produced to a thickness in the range of 0.1mm to 4mm.
- 5 13. A process according to claim 12 wherein the thickness of the third layer is in the range of 0.2 mm to 1mm.
14. A process according to any one of the preceding claims, wherein when there are least 2 layers of fabric in one or both of the first layer and third layer and they
10 are laid such that the weave of subsequent layers of fabric have a substantially orthogonal relationship to each other.
15. A process according to any one of the preceding claims wherein the fabric is selected from a woven twill.
- 15 16. A process according to any one of the preceding claims wherein the fabric is selected from carbon fibre, glass fibre or aramid fibre.
17. A process according to any one of the preceding claims wherein the curable
20 polymer is selected from an epoxy, polyester, polyurethane, vinyl ester or polypropylene.

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18. A process according to any one of the preceding claims, comprising attaching a fourth shock attenuating layer to the energy dispersive polymer composite sandwich structure product.
- 5 19. A process according claim 18, wherein the fourth shock attenuating layer comprises at least one energy dispersive material.
20. A process according to any one of the preceding claims, wherein the pre-formed energy dispersive material is a foam selected from polystyrene, polyethylene, 10 polypropylene, polybutylene, polyvinylchloride or polymethacrylimide foam.
21. A process according to claim 20 wherein the thickness of the foam is in the range of from 3 mm to 25 mm.
- 15 22. A process according to claim 21 wherein the thickness of the foam is in the range of from 7 mm to 15 mm.
23. A process according to any one of claims 18 to 22 wherein the foam has a density in the range of 10 to 120kgm⁻³.
- 20 24. A process as claimed in claim 23 wherein the foam has a density in the range of from 25 to 100kgm⁻³.

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25. A process according to any one of the preceding claims, comprising fixing a fifth comfort liner to the third or fourth layer.

26. A process according to claim 25, wherein the comfort liner is selected from an expanded; polystyrene, polyethylene, polypropylene, polybutylene, polyvinylchloride or polymethacrylimide foam.

27. A process according to claim 25 or claim 26 wherein the thickness of the foam is in the range of from 3 mm to 25 mm.

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28. A process according to any one of claims 25 to 26 wherein the foam has a density in the range of 10 to 120kgm⁻³.

29. A process according to any one of the preceding claims wherein the second pre-formed energy dispersive layer is formed from at least three interconnecting sections.

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30. A process according to claim 29 wherein the interconnecting sections comprise a means of locking engagement.

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31. A process according to claim 30 wherein the means of locking engagement is provided by chamfered abutting edges or are joined by means of a protrusion and co-operative recessed portion.

32. A process according to any one of the above claims wherein the preferred combinations of first and third layer resins and second energy dispersive material are
- 5 Polyester resin and polyurethane or polystyrene foam,
Vinyl ester resin and polyurethane or polystyrene foam,
Epoxy resin and polyurethane or polystyrene foam,
Polyurethane resin and polyurethane or polystyrene foam.
- 10 33. A process according to any one of the preceding claims wherein the method further includes the step of applying a barrier between the polystyrene foam and curable resin to prevent chemical reaction.
34. A process according to claim 33 wherein the barrier contains a spectroscopically active compound to monitor the application.
- 15 35. A process according to claim 33 or claim 34 wherein the barrier is applied to the foam by means of spraying, dipping or brushing.
- 20 36. A process according to claim 35, wherein the uniform impervious barrier is an epoxy adhesive.
37. A process according to any one of the preceding claims, wherein the helmet has a mass less than 2000 grams.

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38. A process according to claim 37, wherein the helmet has a mass in the range of from 500 to 1200 grams.

39. A helmet obtainable by a process according to any one of the preceding claims.

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40. A helmet according to claim 39, wherein the helmet, further incorporates mountings for at least one of the following, chin strap, visor, illumination unit, reflector or head mounted display.

10 41. Use of a helmet according to claim 39 or claim 40 as a means of mitigating head traumas.

42. Use, product, process, kit of parts as herein described with reference to and/or as illustrated in the accompanying figures.